Short communication

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Vegetation dynamics in the Rostov lowland (Yaroslavl oblast) during the Late Glacial and Holocene based on a new pollen data

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ABSTRACT. Our reconstructions of vegetation changes are based on the results of pollen analysis that was carried out for the sedimentary sequence located on the lacustrine-alluvial terrace west of Lake Nero. To clarify our conclusions, six ^{14}C dates were obtained and an age-depth model based on these dates was constructed. It is established that open spruce-birch forests were widespread during the Allerød and Younger Dryas. Since the Preboreal stage of the Holocene, a peat bog began to form surrounded by pine and birch forests with spruce. The Boreal stage was marked by an increased role of broad-leaved trees in the forests. During the Atlantic period, climatic conditions became warmer and spruce-pine forests with thermophilous deciduous trees started to grow. The vegetation cover of the Late Holocene (SB-SA periods) was dominated by spruce forests with pine and birch.

Keywords: pollen, spores, reconstruction of paleoenvironment, peat bog, Lake Nero

1. Introduction

Lake Nero, located in the southern part of the Rostov lowland, has been one of the main paleogeographic objects of study for many years in the Upper Volga region. The lake has a complex Late Glacial and Holocene history due to the changes in its level and the fluvial network transformation. Palynological investigations have already been conducted in this area, but the most of them were poorly provided with absolute dates (Gunova, 1972; Aleshinskaya and Gunova, 1975). Moreover, according to recent studies (Wohlfarth et al., 2006), a hiatus in sedimentation is recorded in the bottom sediments of Lake Nero during the Younger Dryas and the Early Holocene.

For paleogeographic reconstructions, we have chosen a section that is situated on a lacustrine-alluvial terrace west of Lake Nero. This section characterizes the history of the fluvial valley, sedimentation in which continued during the Late Glacial and Holocene. The study of this sedimentary sequence will fill in some gaps and expand the understanding of the vegetation history in the study area.

2. Materials and methods

The main object of this study – the K7C core – is located on the lacustrine-alluvial terrace at an altitude of 11 m above the Lake Nero level (N 57.191579; E 39.310386). The sequence is 2 m long. Core sediments were studied by pollen analysis with sample interval 5-10 cm (37 samples in total). Samples were processed using the method of V.P. Grichuk (Grichuk and Zaklinskaya, 1948) with the acetolysis procedure at the final stage (Mazei and Novenko, 2021). Samples were subsequently examined under the microscope with 400x magnification. The pollen percentage diagram and the pollen concentration diagram were constructed with the TiliaGraph software (Grimm, 2004). On the pollen percentage diagram, the percentage values of all taxa were calculated in the ratio to AP + NAP sum. A cluster analysis was used to identify local pollen zones (hereinafter LPZ).

Radiocarbon dates for 6 samples were obtained in the Laboratory of Nuclear Geophysics and Radioecology (Nature Research Centre, Vilnius, Lithuania), and an age-depth model based on these dates was constructed.

3. Results

The sediment sequence of the K7C core consists of several layers. The basal loam unit (2.0-1.83 m) and peaty loam unit (1.83-1.45 m) pass into peat unit (1.45-0.38 m) with two interbeds of 5-cm-thick organic carbonate silt. The upper part of the core is composed of peaty loam (0.38-0 m).

The pollen diagram commences with the *Betula*-dominated LPZ 1 (2.0-1.63 m) with low *Picea* and *Pinus* s/g *Diploxylon*. The pollen grains of shrubs such as *Betula* sect. *Fruticosae, B.* sect. *Nanae* and *Salix* are found, and

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their concentrations are high (*B.*sect. *Fruticosae* – up to 5000 grains per cm^3, *B.* sect. *Nanae* – up to 500, *Salix* – up to 7000). This pollen zone is also characterized by high NAP and *Artemisia* pollen values. Two subzones can be identified in the LPZ 1: the LPZ 1A (2.0-1.87 m) and the LPZ 1B (1.87-1.63 m). The LPZ 1A has the lowest total pollen concentration of all pollen zones (5000-6000 grains per cm^3); it is also distinguished by higher *Picea* and lower *Artemisia* and Chenopodiaceae compared to the LPZ 1B.

In the following LPZ 2 (1.63-1.18 m), NAP dominates together with Poaceae. According to the results of the botanical composition analysis of peat, which was carried out by Stoykina N.V. in the Laboratory of Wetland Ecosystems (Institute of Biology, Karelian Research Centre RAS), numerous macrofossils of *Phragmites* are found at these levels. In pollen assemblages, AP values constitutes 5-43% of the total pollen and spore sum. *Betula* sect. *Albae* still predominates, but it declines toward to the upper part of the LPZ 2, as does *Picea*. *Pinus* s/g *Diploxylon*, on the contrary, increases in the upper part. Pollen of broad-leaved trees is insignificant. It is worth noting the presence of *Ephedra* and *Thalictrum* pollen in the NAP group.

The next LPZ 3 (1.18-0.57 m) is characterised by high content of *Pinus* s/g *Diploxylon* and *B.* sect. *Albae* together with Cyperaceae. At these levels, great amount of *Carex* macrofossils occurs (according to the results of the botanical composition analysis of peat). Percentages of AP and NAP are approximately equal. Spores are abundant, especially Polypodiaceae. The LPZ 3 should be divided into two subzones. The lower subzone LPZ 3A (1.18-0.87 m) is characterized by the higher content of *Artemisia*, while the upper subzone LPZ 3B (0.87-0.57 m) shows a wide variety of thermophilous deciduous tree pollen (*Quercus, Ulmus, Corylus, Tilia, Lonicera, Sambucus*).

The following LPZ 4 is identified at 0.57-0.22 m depth. An increase of AP values takes place (43-83% of the total pollen and spore sum). *Picea* starts to rise and prevails together with *Pinus* s/g *Diploxylon*. *Alnus* pollen values increase. In this pollen zone, there is an abundance of deciduous tree pollen, namely *Tilia, Quercus, Corylus* and *Ulmus*. Pollen concentrations of these taxa are high (*Quercus* – up to 3000 grains per cm^3, *Tilia* – up to 9000, *Corylus* – up to 6000, *Ulmus* – up to 3000). The content of NAP decreases.

The uppermost LPZ 5 (0.22-0 m) is distinguished by less abundance of thermophilous deciduous tree pollen and lower total pollen concentration compared to the LPZ 4.

4. Discussion

According to the age-depth model and pollen spectra, it can be assumed that the sediment sequence of the K7C core formed from the Allerød to the Late Holocene (SB-SA periods).

The basal alluvial-deluvial loam unit represents a sediment bed that was deposited during the Allerød stage (LPZ 1A). A high terrigenous content and low pollen concentrations indicate a rapid rate of sedimentation. Then, during the Younger Dryas period, sedimentation rates slowed down and peaty loam accumulated (LPZ 1B). Open spruce-birch forests dominated the Allerød and Younger Dryas periods. Open spaces were occupied mainly by xerophytic formations and meadow herbs. During the Preboreal stage (11.75-10.75 cal. ka BP), a peat bog existed above the section. It began to form as a lowland reed wetland (LPZ 2) and subsequently transformed into a sedge wetland (LPZ 3A). Pine and birch forests with spruce grew in the vicinity of the peat bog. Due to ongoing warming (LPZ 3B), pine-birch forests with broad-leaved trees started to grow (the Boreal stage; 10.75-8.2 cal. ka BP). The content of broad-leaved trees gradually increased in the woods. During the Atlantic period (LPZ 4; 8.2-5.3 cal. ka BP), forests became denser. Climatic conditions got even warmer. It caused the widespread of spruce-pine forests with thermophilous deciduous trees. Further (LPZ 5) there were changes to cooling. The Late Holocene (Subboreal-Subatlantic periods) is recorded only in the upper 22 cm of the peaty loam unit in the K7C. The vegetation cover was dominated by spruce forests with pine and birch. The results of other palynological investigations (Wohlfarth et al., 2006) also confirm the predominance of spruce-pine-birch forests during the Late Holocene in the surroundings of Lake Nero.

5. Conclusions

The K7C section is a valuable paleogeographic archive that was characterized by a continuous deposition of sedimentation during the Late glacial and the Holocene. It allowed us to reconstruct vegetation dynamics since the Allerød stage in the vicinity of Lake Nero. The most significant is that almost half of this sequence (0.8 m) is the peat horizon that accumulated during the Preboreal stage of the Holocene. Pollen assemblages of this time span were poorly studied before in this region.

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Conflict of interest

The authors declare no conflict of interest.

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